

APPENDIX B TO PART 238—TEST METHODS AND PERFORMANCE CRITERIA FOR THE FLAMMABILITY AND SMOKE EMISSION CHARACTERISTICS OF MATERIALS USED IN PASSENGER CARS AND LOCOMOTIVE CABS

This appendix contains the test methods and performance criteria for the flammability and smoke emission characteristics of materials used in passenger cars and locomotive cabs, in accordance with the requirements of § 238.103.

(a) *Incorporation by reference.* Certain documents are incorporated by reference into this appendix with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. You may inspect a copy of each document during normal business hours at the Federal Railroad Administration, Docket Clerk, 1200 New Jersey Avenue, SE., Washington, DC 20950 or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html. The documents incorporated by reference into this appendix and the sources from which you may obtain these documents are listed below:

(1) American Society for Testing and Materials (ASTM), 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959.

(i) ASTM C 1166-00, Standard Test Method for Flame Propagation of Dense and Cellular Elastomeric Gaskets and Accessories.

(ii) ASTM D 2724-87, Standard Test Methods for Bonded, Fused, and Laminated Apparel Fabrics.

(iii) ASTM D 3574-95, Standard Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams.

(iv) ASTM D 3675-98, Standard Test Method for Surface Flammability of Flexible Cellular Materials Using a Radiant Heat Energy Source.

(v) ASTM E 119-00a, Standard Test Methods for Fire Tests of Building Construction and Materials.

(vi) ASTM E 162-98, Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

(vii) ASTM E 648-00, Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.

(viii) ASTM E 662-01, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.

(ix) ASTM E 1354-99, Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter.

(x) ASTM E 1537-99, Standard Test Method for Fire Testing of Upholstered Furniture.

(xi) ASTM E 1590-01, Standard Test Method for Fire Testing of Mattresses.

(2) General Services Administration, Federal Supply Service, Specification Section, 470 E. L'Enfant Plaza, SW., Suite 8100, Washington, DC, 20407. FED-STD-191A-Textile Test Method 5830, Leaching Resistance of Cloth; Standard Method (July 20, 1978).

(3) State of California, Department of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation, 3485 Orange Grove Avenue, North Highlands, CA 95660-5595.

(i) California Technical Bulletin (Cal TB) 129, Flammability Test Procedure for Mattresses for Use in Public Buildings (October, 1992).

(ii) Cal TB 133, Flammability Test Procedure for Seating Furniture for Use in Public Occupancies (January, 1991).

(b) *Definitions.* As used in this appendix—

Average heat release rate (\dot{q}''_{180}) means, as defined in ASTM E 1354-99, the average heat release rate per unit area in the time period beginning at the time of ignition and ending 180 seconds later.

Critical radiant flux (C.R.F.) means, as defined in ASTM E 648-00, a measure of the behavior of horizontally-mounted floor covering systems exposed to a flaming ignition source in a graded radiant heat energy environment in a test chamber.

Flame spread index (I_s) means, as defined in ASTM E 162-98, a factor derived from the rate of progress of the flame front (F_s) and the rate of heat liberation by the material under test (Q), such that $I_s = F_s \times Q$.

Flaming dripping means periodic dripping of flaming material from the site of material burning or material installation.

Flaming running means continuous flaming material leaving the site of material burning or material installation.

Heat release rate means, as defined in ASTM E 1354-99, the heat evolved from a specimen per unit of time.

Specific extinction area (σ_f) means, as defined in ASTM E 1354-99, specific extinction area for smoke.

Specific optical density (D_s) means, as defined in ASTM E 662-01, the optical density measured over unit path length within a chamber of unit volume, produced from a specimen of unit surface area, that is irradiated by a heat flux of 2.5 watts/cm² for a specified period of time.

Surface flammability means the rate at which flames will travel along surfaces.

(c) *Required test methods and performance criteria.* The materials used in locomotive cabs and passenger cars shall be tested according to the methods and meet the performance criteria set forth in the following table and notes:

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49 CFR Ch. II (10–1–02 Edition)

**Test Procedures and Performance Criteria for the Flammability and Smoke Emission
Characteristics of Materials Used in Passenger Cars and Locomotive Cabs**

CATEGORY	FUNCTION OF MATERIAL	TEST METHOD	PERFORMANCE CRITERIA
Cushions, Mattresses	All ^{1, 2, 3, 4, 5, 6, 7, 8}	ASTM D 3675-98	$I_s \leq 25$
		ASTM E 662-01	$D_s (1.5) \leq 100$ $D_s (4.0) \leq 175$
Fabrics	Seat upholstery, mattress ticking and covers, curtains, draperies, wall coverings, and window shades ^{1, 2, 3, 6, 7, 8}	14 CFR 25, Appendix F, Part I, (vertical test)	Flame time ≤ 10 seconds Burn length ≤ 6 inches
		ASTM E 662-01	$D_s (4.0) \leq 200$
Other Vehicle Components ^{9, 10, 11, 12}	Seat and mattress frames, wall and ceiling panels, seat and toilet shrouds, tray and other tables, partitions, shelves, opaque windscreens, end caps, roof housings, and component boxes and covers ^{1, 2}	ASTM E 162-98	$I_s \leq 35$
		ASTM E 662-01	$D_s (1.5) \leq 100$ $D_s (4.0) \leq 200$
	Flexible cellular foams used in armrests and seat padding ^{1, 2, 4, 6}	ASTM D 3675-98	$I_s \leq 25$
		ASTM E 662-01	$D_s (1.5) \leq 100$ $D_s (4.0) \leq 175$
	Thermal and acoustic insulation ^{1, 2}	ASTM E 162-98	$I_s \leq 25$
		ASTM E 662-01	$D_s (4.0) \leq 100$
	HVAC ducting ^{1, 2}	ASTM E 162-98	$I_s \leq 35$
		ASTM E 662-01	$D_s (4.0) \leq 100$
	Floor covering ^{12, 13}	ASTM E 648-00	C.R.F. $\geq 5 \text{ kW/m}^2$
		ASTM E 662-01	$D_s (1.5) \leq 100$ $D_s (4.0) \leq 200$
	Light diffusers, windows and transparent plastic windscreens ^{2, 14}	ASTM E 162-98	$I_s \leq 100$
		ASTM E 662-01	$D_s (1.5) \leq 100$ $D_s (4.0) \leq 200$
Elastomers ^{1, 10, 11}	Window gaskets, door nosings, inter-car diaphragms, roof mats, and seat springs	ASTM C 1166-00	Average flame propagation ≤ 4 inches
		ASTM E 662-01	$D_s (1.5) \leq 100$ $D_s (4.0) \leq 200$
Structural Components ¹⁵	Flooring ¹⁶ , Other ¹⁷	ASTM E 119-00a	Pass

¹Materials tested for surface flammability shall not exhibit any flaming running or dripping.

²The ASTM E 662 01 maximum test limits for smoke emission (specific optical density) shall be measured in either the flaming or

¹Materials tested for surface flammability shall not exhibit any flaming running or dripping.

²The ASTM E 662-01 maximum test limits for smoke emission (specific optical density) shall be measured in either the flaming or

non-flaming mode, utilizing the mode which generates the most smoke.

³Testing of a complete seat assembly (including cushions, fabric layers, upholstery) according to ASTM E 1537–99 using the pass/fail criteria of Cal TB 133, and testing of a complete mattress assembly (including foam and ticking) according to ASTM E 1590–01 using the pass/fail criteria of Cal TB 129 shall be permitted in lieu of the test methods prescribed herein, provided the assembly component units remain unchanged or new (replacement) assembly components possess equivalent fire performance properties to the original components tested. A fire hazard analysis must also be conducted that considers the operating environment within which the seat or mattress assembly will be used in relation to the risk of vandalism, puncture, cutting, or other acts which may expose the individual components of the assemblies to an ignition source. Notes 5, 6, 7, and 8 apply.

⁴Testing is performed without upholstery.

⁵The surface flammability and smoke emission characteristics shall be demonstrated to be permanent after dynamic testing according to ASTM D 3574–95, Test I₂ (Dynamic Fatigue Test by the Roller Shear at Constant Force) or Test I₃ (Dynamic Fatigue Test by Constant Force Pounding) both using Procedure B, except that the test samples shall be a minimum of 6 inches (154 mm) by 18 inches (457 mm) by the thickness of the material in its end use configuration, or multiples thereof. If Test I₃ is used, the size of the indenter described in paragraph 96.2 shall be modified to accommodate the specified test specimen.

⁶The surface flammability and smoke emission characteristics shall be demonstrated to be permanent by washing, if appropriate, according to FED-STD-191A Textile Test Method 5830.

⁷The surface flammability and smoke emission characteristics shall be demonstrated to be permanent by dry-cleaning, if appropriate, according to ASTM D 2724–87.

⁸Materials that cannot be washed or dry-cleaned shall be so labeled and shall meet the applicable performance criteria after being cleaned as recommended by the manufacturer.

⁹Signage is not required to meet any flammability or smoke emission performance criteria specified in this Appendix.

¹⁰Materials used to fabricate miscellaneous, discontinuous small parts (such as knobs, rollers, fasteners, clips, grommets, and small electrical parts) that will not contribute materially to fire growth in end use configuration are exempt from flammability and smoke emission performance requirements, provided that the surface area of any individual small part is less than 16 square inches (100 cm²) in end use configuration and an appropriate fire hazard analysis is con-

ducted which addresses the location and quantity of the materials used, and the vulnerability of the materials to ignition and contribution to flame spread.

¹¹If the surface area of any individual small part is less than 16 square inches (100 cm²) in end use configuration, materials used to fabricate such a part may be tested in accordance with ASTM E 1354–99 as an alternative to both (a) the ASTM E 162–98 flammability test procedure, or the appropriate flammability test procedure otherwise specified in the table, and (b) the ASTM E 662–01 smoke generation test procedure. Testing shall be at 50 kW/m² applied heat flux with a retainer frame. Materials tested in accordance with ASTM E 1354–99 shall meet the following performance criteria: average heat release rate (\dot{q}'_{180}) less than or equal to 100 kW/m², and average specific extinction area (σ_T) less than or equal to 500 m²/kg over the same 180-second period.

¹²Carpeting used as a wall or ceiling covering shall be tested according to ASTM E 162–98 and ASTM E 662–01 and meet the respective criteria of I_s less than or equal to 35 and D_s (1.5) less than or equal to 100 and D_s (4.0) less than or equal to 200. Notes 1 and 2 apply.

¹³Floor covering shall be tested with padding in accordance with ASTM E 648–00, if the padding is used in the actual installation.

¹⁴For double window glazing, only the interior glazing is required to meet the requirements specified herein. (The exterior glazing is not required to meet these requirements.)

¹⁵Penetrations (ducts, etc.) shall be designed against acting as passageways for fire and smoke and representative penetrations shall be included as part of test assemblies.

¹⁶A structural flooring assembly separating the interior of a vehicle from its undercarriage shall meet the performance criteria during a nominal test period as determined by the railroad. The nominal test period must be twice the maximum expected time period under normal circumstances for a vehicle to stop completely and safely from its maximum operating speed, plus the time necessary to evacuate all the vehicle's occupants to a safe area. The nominal test period must not be less than 15 minutes. Only one specimen need be tested. A proportional reduction may be made in the dimensions of the specimen provided it serves to truly test the ability of the structural flooring assembly to perform as a barrier against under-vehicle fires. The fire resistance period required shall be consistent with the safe evacuation of a full load of passengers from the vehicle under worst-case conditions.

¹⁷Portions of the vehicle body which separate major ignition sources, energy sources, or sources of fuel-load from vehicle interiors, shall have sufficient fire endurance as determined by a fire hazard analysis acceptable to

the railroad which addresses the location and quantity of the materials used, as well as vulnerability of the materials to ignition, flame spread, and smoke generation. These portions include equipment carrying portions of a vehicle's roof and the interior structure separating the levels of a bi-level car, but do not include a flooring assembly subject to Note 16. A railroad is not required to use the ASTM E 119-00a test method.

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APPENDIX C TO PART 238 [RESERVED]

APPENDIX D TO PART 238—REQUIREMENTS FOR EXTERNAL FUEL TANKS ON TIER I LOCOMOTIVES

The requirements contained in this appendix are intended to address the structural and puncture resistance properties of the locomotive fuel tank to reduce the risk of fuel spillage to acceptable levels under derailment and minor collision conditions.

(a) *Structural strength*—(1) *Load case 1—minor derailment*. The end plate of the fuel tank shall support a sudden loading of one-half the weight of the car body at a vertical acceleration of 2g, without exceeding the ultimate strength of the material. The load is assumed to be supported on one rail, within an eight inch band (plus or minus) at a point nominally above the head of the rail, on tangent track. Consideration should be given in the design of the fuel tank to maximize the vertical clearance between the top of the rail and the bottom of the fuel tank.

(2) *Load case 2—jackknifed locomotive*. The fuel tank shall support transversely at the center a sudden loading equivalent to one half the weight of the locomotive at a vertical acceleration of 2g, without exceeding the ultimate strength of the material. The load is assumed to be supported on one rail, distributed between the longitudinal center line and the edge of the tank bottom, with a rail head surface of two inches.

(3) *Load case 3—side impact*. In a side impact collision by an 80,000 pound Gross Vehicle Weight tractor/trailer at the longitudinal center of the fuel tank, the fuel tank shall withstand, without exceeding the ultimate strength, a 200,000 pound load (2.5g) distributed over an area of six inches by forty-eight inches (half the bumper area) at a height of thirty inches above the rail (standard DOT bumper height).

(4) *Load case 4—penetration resistance*. The minimum thickness of the sides, bottom sheet and end plates of the fuel tank shall be equivalent to a $\frac{5}{16}$ -inch steel plate with a 25,000 pounds-per-square-inch yield strength (where the thickness varies inversely with the square root of yield strength). The lower one third of the end plates shall have the

equivalent penetration resistance by the above method of a $\frac{3}{4}$ -inch steel plate with a 25,000 pounds-per-square-inch yield strength. This may be accomplished by any combination of materials or other mechanical protection.

(b) *Sideswipe*. To minimize fuel tank damage during sideswipes (railroad vehicles and grade crossings), all drain plugs, clean-out ports, inspection covers, sight glasses, gauge openings, etc., must be flush with the tank surface or adequately protected to avoid catching foreign objects or breakage. All seams must be protected or flush to avoid catching foreign objects.

(c) *Spill controls*. Vents and fills shall be designed to avert spillage of fuel in the event of a roll over.

APPENDIX E TO PART 238—GENERAL PRINCIPLES OF RELIABILITY-BASED MAINTENANCE PROGRAMS

(a) Any maintenance program has the following four basic objectives:

(1) To ensure realization of the design level of safety and reliability of the equipment;

(2) To restore safety and reliability to their design levels when deterioration has occurred;

(3) To obtain the information necessary for design improvements of those items whose design reliability proves inadequate; and

(4) To accomplish these goals at a minimum total cost, including maintenance costs and the costs of residual failures.

(b) Reliability-based maintenance programs are based on the following general principles. A failure is an unsatisfactory condition. There are two types of failures: functional and potential. Functional failures are usually reported by operating crews. Conversely, maintenance crews usually discover potential failures. A potential failure is an identifiable physical condition, which indicates that a functional failure is imminent. The consequences of a functional failure determine the priority of a maintenance effort. These consequences fall into the following general categories:

(1) Safety consequences, involving possible loss of the equipment and its occupants;

(2) Operational consequences, which involve an indirect economic loss as well as the direct cost of repair;

(3) Non-operational consequences, which involve only the direct cost of repair; or

(4) Hidden failure consequences, which involve exposure to a possible multiple failure as a result of the undetected failure of a hidden function.

(c) In a reliability-based maintenance program, scheduled maintenance is required for any item whose loss of function or mode of failure could have safety consequences. If preventative tasks cannot reduce the risk of such failures to an acceptable level, the item